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OBSERVATIONS ON AMPHIUMA AND ITS YOUNG.

BY O. P. HAY, M.D.[1]

THE waters of our Southern States are inhabited by certain elongated air-breathing animals, which are popularly known and feared under the name of Congo Snakes; although they in reality belong not among the serpents, but to the class of Amphibians. Of these animals, naturalists have up to near the present time recognized two species, and even two distinct genera, Amphiuma and Muræenopsis, the two forms being distinguished by the possession respectively of two and three digits to each of their very feebly developed legs. The occasional finding of specimens with two toes on some of the feet, and three on the others, has cast doubt on the generic value of this character, and made it quite certain that both belong to the same genus.[2] As there are few or no other differences of importance between the two supposed species, it is now thought by some batrachologists that there is after all but a single species; and this is the view at present held, I believe, by Professor E. D. Cope, the best American authority on such matters.[3] *Amphiuma* (*Murœnopsis*) *tridactylum* is, in this case, to be regarded as merely a variety of *A. means.*

Of the habits, especially the breeding habits, of the lower Amphibia, in species of which North America is rich beyond all other countries, little appears to have been discovered. Siren, Necturus, Amphiuma and Cryptobranchus are all strictly aquatic, or nearly so, in their manner of life. With a few remarkable exceptions, our Amphibia, whether affecting a terrestrial or an aquatic habit in adult life, lay their eggs in the water; and the young, for a time after hatching, live in that element, and breathe by means of gills. In cases where the young of a species have not been discovered, it has been assumed that they possess gills, which are afterward absorbed.

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[1] Published by permission of Dr. John C. Branner, Director of the Arkansas Geological Survey.

[2] Ryder, Proc. Phil. Acad., 1879, p. 14.

[3] Proceedings Amer. Philosoph. Soc. 1886, p. 526.

This assumption has been made in the case of Amphiuma. On general principles, Cuvier concluded that in early life it has gills. This was uncertain, and has been denied. Later authorities, among them Professor Huxley, state that its gills are "caducous," but that this conclusion rests on any one's observations I am not aware. Of its other habits little seems to be known. Holbrook, in his great work on North American Reptiles, thus speaks of the species:—

"*Amphiuma means* lives in muddy water or in mud. Harlan says they have been found at Pensacola three feet or more deep in mud of the consistency of mortar, in which they burrow like earthworms. They inhabit the ditches of our rice-fields, and feed on small fish and various fresh-water shells, as Unio, etc.; beetles and other insects have also been found in their stomachs. Sometimes, like eels, they are found on dry land, but for what purpose they approach it is unknown" (N. A. Herp., 1842, v., 91).

"I am unacquainted with the habits of the *Amphiuma tridactylum*, but suppose these to be similar to those of the *Amphiuma means*" (Ibid., 93).

At the close of August, 1887, I spent a few days in Little Rock, Ark., in the employ of Dr. Branner, of the Arkansas Geological Survey. On September 1st I visited a cypress swamp in the vicinity of the city for the purpose of collecting some reptiles. During the severe summer drought this swamp had been almost completely dried up, and there was little chance to get anything except by turning over pieces of fallen timber. Beneath a log of considerable size I found, to my surprise, a large animal coiled up, which by its smooth glistening skin I immediately saw could not be a snake; but, having never before seen a living Amphiuma, it took me some time to realize that I had before me one of these animals. After making due preparations to prevent its escape, I gave the animal a push with a stout stick, and then, no attempt at retreat being made, I lifted it out of the slight depression in which it was lying and let it straighten itself out. Meanwhile I had observed, lying in the midst of the coils, a mass of moist-looking matter, nearly as large as one's fist. Picking this up, I discovered it to be a mass of eggs. This was put into a jar of alcohol, and immediately the young within the egg could be seen writhing about, thus showing that they were in an advanced stage of development. The mother offered no resistance on being handled, and was put into a small school satchel and carried to the State Geologist's office, a mile away, with two empty fruit jars lying on her. That night she was kept in an empty boot-box. This was some eighteen inches in height, and from it she made efforts to escape. She would erect herself in one corner until her head was on a level with the edge of the box, but she could get no further. Once in falling down she uttered a shrill sound somewhat like a whistle or the peeping of a young chicken. A cry like that of a young duck has been attributed by some observer to the Siren, but Barton in some of his writings denies the statement that such a sound is made.

The limbs of these animals are very small. For instance, of this one, having a length of thirty-one inches, the hinder limbs are only three-fourths of an inch long, the anterior only one-half an inch. Yet, when it was moving over the ground or the floor, it was amusing to observe that its feet were put forward and drawn back, as if they really could be of some use.

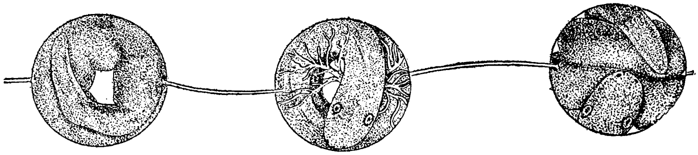
On irritating this Amphiume by pushing her with a stick she would snap at it viciously, and on further irritation would seize it in her jaws and, springing from the floor in the form of a spiral, would turn rapidly round and round, thus twisting the stick in one's hand. Any enemy thus attacked would certainly find his interest in the affair fully aroused.

There are two points in the structure of the adult to which I wish to call attention; although no doubt they have already been observed by anatomists. The first is that there is a little lobe of skin forming the anterior boundary of the gill-opening, and another forming the posterior border. These can be very closely applied to each other, and seem to form a very efficient valvular apparatus, by means of which this useless relic of its larval life may be closed up. The other structure is connected with the mouth. The lower lip is formed of a fold of skin that is separated from the skin of the throat by a deep groove that runs from the corner of the mouth to near the symphysis. This fold has a thin sharp edge, and is directed downward and outward. The upper lip also has a sharp edge which, when the mouth is closed, widely and closely overlaps the lower lip. This arrangement of the lips and that of the gill opening seems to me to have relation to the burrowing habits of these animals, and are designed to prevent the mouth and pharynx from being filled with mud.

The eggs of the Amphiume are the most remarkable that I know of as occurring among the Amphibians. The young, which now constitute the whole contents of the eggs, are surrounded by a transparent capsule about as thick as writing paper, and these capsules are connected by a slender cord of similar substance. It is as if the gelatinous mass surrounding the eggs of the toad should become condensed into a solid covering and a connecting cord. How many strings there are of these eggs I cannot determine with certainty, on account of their being inextricably intertwined; but, since there are four ends visible, there are probably two strings, one for each oviduct. For the same reason I have not been able to count the eggs. A careful estimate makes at fewest 150 of them.

The eggs, in their present state, are nearly globular, and average about 9 mm. in diameter. Their distance apart on the string varies from 5 to 12 mm.; fourteen of them were counted on a piece of the string nine inches long. At this rate the whole mass would form a string about eight feet long. The connecting cord varies from 1.5 mm. to one-half that diameter. The eggs greatly resemble a string of large beads.

The young are coiled within the capsules in a spiral form. On removing them and straightening them they measure about 45 mm. in length. The color is dusky above, with indications of a darker dorsal stripe, and on each side a similar darker band. Below, the color is pale. The body is proportionally stouter than in the adult and the head broader. The fore and the hind feet have each three toes.



The young possess conspicuous gills; and, since they are evidently near the period of hatching, it is but fair to suppose that they would continue to retain these gills for some time after exclusion. The gills are three in number on each side, and are simply pinnate in form. The median gill is longest, measuring some 9 mm. in length. From its main axis there arise about ten delicate twigs. The other gills are somewhat shorter, and give origin to about eight lateral twigs each. In all these filaments may be seen the bloodvessels filled with the large blood-corpuscles for which Amphiuma is noted. Three gill-slits are open, of which the two posterior become closed in the adult. The eyes appear to better advantage than later in life.

The finding of these young, nearly ready for active life, in such an unexpected situation suggests some interesting problems. At what period of their development are these eggs deposited? If at an early period, the mother must incubate them for a considerable time. If at a late period, why should they be placed in such a situation? In either case it appears to be quite probable that they are fertilized before they are deposited. Again, how are the eggs in such a dry situation saved from being thoroughly desiccated? They are, I think, kept moist by the body of the mother as she lies coiled around them. My remembrance of her as she lay when first exposed is that she was much plumper than she now appears in alcohol; and when she was laid down on the office floor every spot she touched was made wet. The source of this water I do not know; but it appears probable that it came from the numerous glands that fill the skin, and that the mother makes nocturnal visits to the water to lay in supplies.

Another question to be considered is this: What is to become of the young when they are hatched? How can these feeble little animals make their way to the water some rods away over ground that is covered with rubbish, dry, and full of cracks? How is it brought about that their delicate gills are not withered when exposed to the dry air? Is it possible that, like some species of snakes, the young crawl down the mother's throat while she carries them to the water? It has been suggested to me that just before hatching she may carry the eggs in her mouth to the water; but the whole mass could not be taken into the mouth, and she could only carry them as a dog carries a large bone. It is evident that we have several things yet to learn about the habits of Amphiuma.

By means of dissections and microscopical sections I have made some observations on the structure of the young of the Amphiuma as they were found in the eggs above described. A thorough study is being made of these embryos, and I hope soon to publish a paper giving details and drawings. I here note the most salient features of the skull and shoulder girdle.

As might be expected of the young Amphiume, hatched in a situation removed for some distance from the water in which it is to pass the greater part of its life, and to which it must with some difficulty find its way, its whole organization is in a far more advanced stage of development than is that of those Amphibia which are excluded directly into their yielding native element. A comparison of the skull of the young Amphiume with that of the larval axolotl, as described by Messrs. Parker and Bettany, shows that the former corresponds in many respects to the earlier phases of the fifth stage of the latter. The axolotl in this stage is 1¼ inch in length, but when hatched was only about one-third of an inch long (Morphology of the Skull, p. 107).

One of the most interesting features of the skull is the deficiency of cartilage in some regions. The otic capsule is well developed and large. Enclosed within it are the semicircular canals and a large otolith. The notochord runs well forward and is partially ensheathed with bone. The exoccipitals, also, are ossified down almost to the notochord, and the ossification extends into the condyles. On each side there is a narrow band of cartilage that rises up from the hinder end of the ear-capsule toward the middle line, but it lacks considerably of meeting its fellow. Nowhere does the cartilage extend to the middle line above the brain, and nowhere is the brain-cavity roofed over with bone. In the basilar region there is on each side of the notochord a large elliptical fenestra in the cartilage, so that there is only a narrow band lying along each side of the notochord, and a very narrow strip attached to each otic capsule. The trabeculæ are united around the extremity of the notochord, and send back on each side a process to the otic cartilages. These trabeculæ enclose a very large oval pituitary space. They are narrow and, meeting in front in the ethnoidal region, coalesce for a very short distance. There are very short decurved cornua and narrow bands that run outward beneath the nasal sacs. From each trabecula there is given off on the outside a band of cartilage that runs forward and outward, and near its termination sends outward a narrow strip of cartilage over the posterior end of the nasal sacs. This process I regard as the antorbital. There is what appears to be a small postpalatine and a small pterygoid cartilage that does not extend back to the suspensorium. The latter is broad and is directed forward. There is a stapes with the facial nerve passing *beneath* it. Meckel's cartilage runs forward nearly to the symphysis. The hyoidean arch consists of a short hypohyal and a longer ceratohyal. The latter has along its inner side a narrow and easily separable splint of bone. The branchial apparatus is much as in the adult. The first arch is partially ossified. No other ossifications than those mentioned are found in the cartilaginous cranium.

There are several membrane bones. A large parasphenoid underlies the pituitary space and the basilar region. In front of this, in the roof of the mouth, are dentigerous vomers. The maxillaries are probably not represented by actual ossifications, but two rows of dental papillæ shows where they will appear. There is no palatine or pterygoid. The premaxillaries are present and completely consolidated. Their nasal spine is long and they bear prominent teeth. The side walls of the skull are protected by small frontals and larger parietals, but it is the frontal process alone of the parietal that is present. The suspensorium is partially covered by a squamosal.

The Meckelian cartilage appears to be ensheathed, as in the adult, by only two bones. One of these is the dentigerous dentary, which almost meets its platetrope at the symphysis. The other, lying along the inner side of the mandible, extends from the posterior extremity of Meckel's cartilage to a point two-thirds of the distance to the symphysis. It may be regarded as an angulo-splenial. It bears no teeth, as does the splenial frequently in the urodeles.

The shoulder girdle consists of scapular, coracoidal and precoracoidal portions, with no ossifications. These elements lack much of meeting in the middle line of the body below. There are a humerus, radius and ulna, carpals and phalanges. The humerus alone has a center of ossification.

The anterior vertebræ, at least, are ossified, the neural arches having coalesced with the sheath of bone surrounding the notochord. The upper portion of the neural arch is not yet ossified.

Only cursory observations have been made on the brain. As a whole it is far less elongated than in the adult. This shortening is due principally to the prosencephalic lobes, more than half of whose length lies alongside of the di- and metencephalon. Laterally, the epencephalic folds run so far forward as almost to touch the posterior extremity of the cerebral hemispheres.